A2 Kennack Sands

[SW 734 165]

Highlights

This is the type locality for the Kennack Gneiss Group, and it shows good exposures of 'primary' peridotite.

Introduction

The Kennack Gneiss Group is a series of inter-banded mafic and felsic gneisses with associated gabbros, basaltic dykes and granites, that occur along the east coast of the lizard, from Kennack Sands south to Church Cove, and in some of the valleys inland from there. They have been one of the most enigmatic and controversial rock groups of the Lizard Complex, and in this review they are covered by two sites, this locality and one at Polbarrow. To avoid repetition, the introduction for both sites is given here and the discussion at the end of the Polbarrow site description.

Early workers, and indeed most subsequent authors, have found this to be a most perplexing group of rocks. De la Beche (1839) recognized the intrusive nature of the banded gneisses into the peridotite, both here and at Parn Voose site (Polbarrow), but many other localities now attributed to the Kennack Gneiss were originally mapped as hornblende schist. Bonney (1877a) assigned the Gneisses to his 'granulitic group', and suggested that they were highly metamorphosed sediments, with the banding being an expression of the original sedimentary bedding. In contrast to De la Beche (1839), he proposed that the peridotite was intruded into the granulitic group. He noted the similarity of the gneissic rocks to those in north-west Scotland, which led him to suggest that these and the other metamorphic rocks of the Lizard were Archaean in age.

Teall (1887) described the felsic portion of the gneiss as intruding into the mafic and, therefore, that the rocks were igneous and not sedimentary. The banding was due to a 'rolling out' of this intrusive material under pressure, a kind of fluxion structure. Somervail (1888) described the intrusive nature of the felsic portion of the gneiss into the peridotite. Bonney and McMahon (1891) accepted that the banding of the gneisses might be due to fluxioning of mafic rock intruded by felsic rocks, but still maintained that they were older and that the peridotite was intruded into them. Lowe (1901, 1902) stoutly maintained that the 'granulitic group' was the youngest of the area, drawing attention to the conformable nature of the fluxion banding, the numerous inclusions and peripheral alteration of peridotite blocks in the gneiss.

This general view was accepted by Flett and Hill (1912) in the Lizard Memoir. Flett described the field relations in great detail showing that the felsic fraction intrudes the mafic fraction, and that both intrude the peridotite. The banding and many of the structures observed were due to the fluxioning together of composite intrusions of felsic and mafic magmas while they were still hot, together with some reaction to produce rocks of intermediate composition. He also recognized a group of granitic rocks, not accompanied by mafic rocks, that he called the Kennack Granite. Bonney (1914), however, was still reluctant to accept that the 'granulitic group' was younger than the peridotite. Flett's views were restated with little alteration in the second edition of the Lizard Memoir (Flett, 1946).

More recently, Sanders (1955) has restudied the Kennack Gneiss and the structures along the south-east coast of the Lizard. He made the then radical suggestion that the form of the peridotite was a thin sheet rather than the plug-like intrusion accepted by all previous workers. He also suggested that the Kennack Gneisses were a thin development immediately beneath the peridotite, formed by migmatization of the Landewednack Hornblende Schists.

Green (1964c), in his study of the Lizard, largely devoted himself to the peridotite, but also discussed the Kennack Gneiss. He generally accepted Flett's views suggesting *lit-par-lit* injection of felsic magmas into mafic sills, but thought that there was no need for actual mixing of the magmas.

Strong *et al.* (1975), in a brief paper proposing an ophiolitic nature for the Lizard, preferred Sanders' (1955) view that the gneisses were migmatites. Bromley (1979) discussed the migmatitic and intrusive models and favoured an intrusive origin by deformation of a felsic net-vein complex. Kirby (1979a) carried out a detailed field and chemical study, and came to the conclusion that the gneisses were probably formed by the migmatization of Old Lizard Head metasediments and Landewednack Hornblende Schists. Styles and Kirby (1980) described a borehole at Kennack where a considerable thickness of gneisses were intersected (150 m). They stressed the heterogeneity of the gneiss group. and, with a few words of caution, supported the conclusion of Kirby (1979a).

Styles and Rundle (1984) carried out a Rb/Sr isotopic study of a granite vein from the Kennack borehole. They obtained an age of 369 ± 12 Ma (mid-Devonian), which finally put to rest any lingering thoughts that the gneisses might be Precambrian and, as the initial ratio was low (0.70424 ± 0.00009), they were unlikely to have originated from melting of old crustal material. They suggested that the source consisted of a high proportion of mantle or juvenile crustal material.

Subsequently, Barnes and Andrews (1986) have briefly described the field relations of the Kennack Gneisses, and suggested the simultaneous existence of felsic and mafic magmas. They reinterpreted Kirby's (1979a, 1979b) chemical data, and have suggested that the low incompatible-element contents of the felsic portion do not fit with an origin by melting of amphibolite, but by melting of depleted continental crust material. This mixing of such a magma with oceanic-basalt material possibly occurred in an intracratonic setting where ocean crust was being formed in a rift. However, Malpas and Langdon (1987) presented new major- and trace-element data to support an origin by melting of a mixture of Old Lizard Head metasediments and Landewednack Hornblende Schists, a model similar to that proposed by Kirby (1979b).

The most recent and most detailed study of all is that by Sandeman (1988), who produced maps at a scale of 1:1500 and described many field relations in great detail.

Sandeman (1988) points out the relationships between the different components and concludes that two magmas must have been present, at the same time. The felsic was slightly later than the mafic and both physical intermingling and chemical mixing between the two magmas took place. His detailed chemical studies show that the magmas did not have any close relationship prior to their mixing during intrusion. The mafic magma has the chemical characteristics of a calc-alkaline basalt, probably associated with a volcanic arc. After mixing with the granitic magma the composite 'magma package' was intruded along shear zones and faults.

Description

The outcrops along the cliffs and foreshore to the south of the stream at Kennack Sands are some of the best to show the relationships between the various components of the Kennack Gneiss Group and other rock types including peridotite, basaltic dykes and gabbro veins. A sketch map shows the main features (Figure 3.9).

The outcrop in the low cliff a few yards south of the stream shows some of the classic features of the Kennack Gneiss; it was figured by Flett and Hill (1912). Here a vein of banded gneiss intrudes the peridotite as a steep, dyke-like body, with faulting along the northern contact. The felsic portion of the gneiss is slightly younger than the mafic which it cross-cuts locally, but they appear to have been intruded essentially together. The banded gneiss vein truncates a gabbro pegmatite vein to the north and a basaltic dyke to the south, demonstrating that it is the latest intrusive phase in the vicinity.

The banded gneisses in the outcrops close to the cliff are generally of the finely banded variety with subequal proportions of the felsic and mafic components, in bands usually a few centimetres thick (Figure 3.10). In many places, it can be seen that the felsic portion is the younger, particularly in the more mafic varieties where they are cut by numerous thin felsic veins. The degree of deformation is always high, and at least two phases of high-temperature folding can be seen.

The large rocks lying further from the cliffs are composed largely of granite gneiss sheets, several metres in thickness with much thinner interlayers of mafic gneiss. On the seaward side of one of the first large rocks encountered, is a vein of gabbroic to dioritic composition with abundant subrounded xenoliths of gabbro and numerous plagioclase xenocrysts. The large plagioclases, so clearly xenocrysts in this rock, are probably of a similar origin to the 'phenocrysts' in the more homogeneous, fine-grained dioritic rocks nearby.

At Thorny Cliff there are distinctive hybrid rocks. They consist of a monzodioritic host containing blocks of a fine mafic rock. The mafic rocks have a marked lobate outline and appear to have undergone partial digestion by the more felsic host. This is good evidence that here has been assimilation of the mafic rocks to form hybrids of intermediate composition.

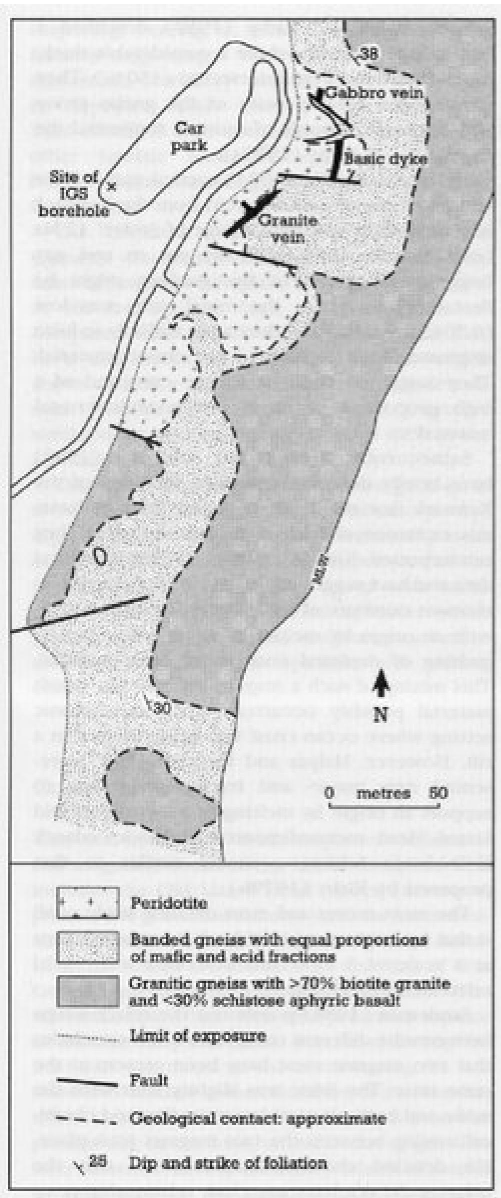
The peridotite exposed along the cliffs at Kennack is relatively fresh, often showing only around 50–60% serpentinization. The rock is very dark green, with prominent, large, bronzy orthopyroxenes up to 10 mm in size and small, dark-green clinopyroxenes. There is a steep foliation trending roughly north–south and a compositional banding due to variation in the proportion of pyroxene, with thin pyroxenite bands in a few places. The contacts between peridotite and the felsic portion of the gneiss are characterized by marked alteration with the formation of various secondary minerals, including talc and chlorite. However, the most striking alteration is to an asbestiform magnesian amphibole.

The features seen along this beach section clearly show that the felsic portion of the gneisses is younger than the peridotite and also the pegmatitic gabbro and basic dykes.

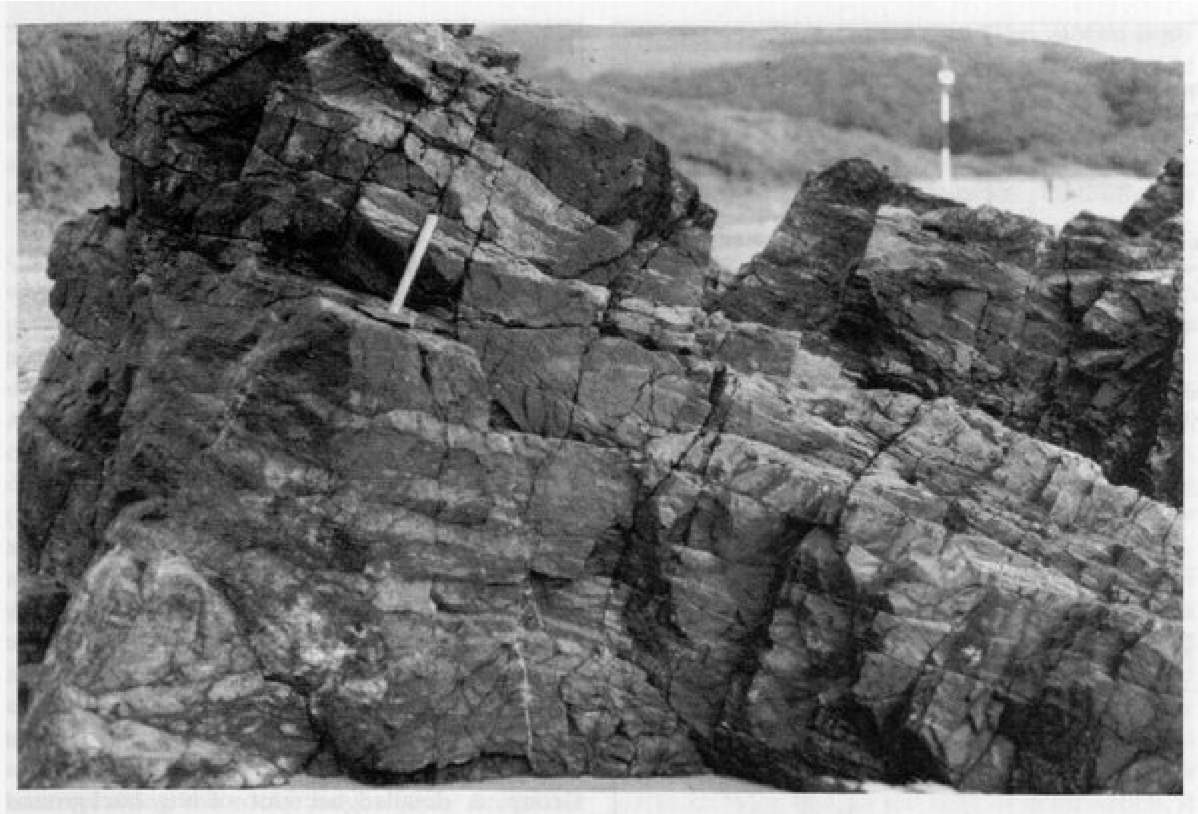
Interpretation and conclusions

See A3 Polbarrow–The Balk [SW 717 135]–[SW 715 128] below

References



(Figure 3.9) Geological sketch map of the Kennack Sands site (A2).



(Figure 3.10) Banded gneiss, Kennack Sands. (Photo: M.T. Styles.)